

REMARKS

Claims 1, 7, 14, 21, 22, and 32 are currently amended. Claim 32 is amended to correct for an error in antecedent basis and not to overcome any art. Claim 4 has been canceled. Applicant respectfully submits that the amendments contained herein are fully supported by the Specification as originally filed and do not include new matter.

Claim Rejections Under 35 U.S.C. § 102

Claims 1-7, 11-17, 32-36 were rejected under 35 U.S.C. § 102(e) as being anticipated by Rathore et al. (U.S. Patent No. 6,258,710). Applicant respectfully traverses.

Claim 1, as currently amended, recites a first metal layer on a diffusion barrier layer, where the first metal layer has a first metal component and a second metal component forming a crystalline compound with the first metal component and where the first metal component is selected from the group consisting of silver, gold, palladium, platinum, rhenium, iridium, ruthenium and osmium. This is different from Rathore et al.

Rathore et al. (Figures 3 and 4, column 8, lines 1-3) includes a layer 5 of an adhesive and contact metal, preferably titanium, tantalum, tantalum nitride, tantalum, chromium, tungsten, or any combination of these layers. An optional thermal diffusion barrier layer 6 (Figures 3 and 4, column 8, lines 5-9) of material such as chromium-chromium oxide, tungsten-silicon, tungsten-nitride, tungsten-nitride-silicon, titanium-nitride, tantalum or tantalum-nitride is disposed on layer 5. Rathore et al. further includes a layer 7 (Figure 3, column 8, lines 31-35) of an element that is capable of forming an intermetallic compound with copper that is disposed on layer 6. Such an element may be selected from the group consisting of hafnium, lanthanum, zirconium, tin and titanium. A thin copper seed layer 8 is formed on layer 7, and a copper layer 9 is formed on copper seed layer 8 (Figure 3, column 8, lines 37-38 and lines 55-57). Heating causes layer 7 to react with the copper layers to form a layer of copper intermetallic compound 10 on layer 6 (Figure 4 and column 8, lines 61-67). The intermetallic compounds formed in the copper layer may be hafnium cupride (Hf_2Cu), lanthanum cupride (LaCu_2), eta-bronze (Cu_6Sn_5), titanium cupride (TiCu) and zirconium cupride (Zr_2Cu). However, none of layers 5, 6, 7, 8, 9 or 10 of Rathore et al. is metal layer having a first metal component selected from the group consisting of silver, gold, palladium, platinum, rhenium, iridium, ruthenium and osmium, as recited in claim 1.

Therefore, Rathore et al. does not include each and every recitation of claim 1, so claim 1 should be allowed.

Claims 2-6 depend from claim 1 and are thus allowable for at least the same reasons as claim 1. Therefore, claims 2-6 should be allowed.

Claim 7, as currently amended, recites a first metal layer on a layer of titanium nitride, where the first metal layer includes a crystalline alloy compound containing a first metal component and a second metal component, where the first metal component is selected from the group consisting of silver, gold, palladium, platinum, rhenium, iridium, ruthenium and osmium. This is different from Rathore et al.

As indicated above in conjunction with claim 1, layer 5 of Rathore et al. is preferably titanium, tantalum, tantalum nitride, tantalum, chromium, tungsten, or any combination of these layers. None of these layers or combinations thereof is a layer of titanium nitride. However, as indicated above, thermal diffusion barrier layer 6 of Rathore et al. can be a layer of titanium nitride. As further indicated above, a layer 7 of an element (hafnium, lanthanum, zirconium, tin and titanium) that is capable of forming an intermetallic compound with copper is disposed on layer 6; a thin copper seed layer 8 is formed on layer 7; and a copper layer 9 is formed on copper seed layer 8. Heating causes the layer 7 to react with the copper layers to form a layer of copper intermetallic compound 10 (hafnium cupride (Hf_2Cu), lanthanum cupride (LaCu_2), eta-bronze (Cu_6Sn_5), titanium cupride (TiCu) and zirconium cupride (Zr_2Cu)) on layer 6. However, the layer of copper intermetallic compound 10 formed on layer 6 does not include a crystalline alloy compound containing a first metal component and a second metal component, where the first metal component is selected from the group consisting of silver, gold, palladium, platinum, rhenium, iridium, ruthenium and osmium, as recited in claim 7, nor do layers 7, 8, and 9. Therefore, Rathore et al. does not include each and every recitation of claim 7, so claim 7 should be allowed.

Claims 11-13 depend from claim 7 and are thus allowable for at least the same reasons as claim 7. Therefore, claims 11-13 should be allowed.

Claim 14, as currently amended, recites a first metal layer on a titanium nitride layer, where the first metal layer comprises copper and a metal component forming a crystalline

compound with the copper, where the metal component is selected from the group consisting of scandium and yttrium. This is different from Rathore et al.

As indicated above in conjunction with claim 1, layer 5 of Rathore et al. is preferably titanium, tantalum, tantalum nitride, tantalum, chromium, tungsten, or any combination of these layers. None of these layers or combinations thereof is a layer of titanium nitride. However, as indicated above, thermal diffusion barrier layer 6 of Rathore et al. can be a layer of titanium nitride. As further indicated above, a layer 7 of an element (hafnium, lanthanum, zirconium, tin and titanium) that is capable of forming an intermetallic compound with copper is disposed on layer 6. However, there is no indication in Rathore et al. of a metal component forming a crystalline compound with copper, where the metal component is selected from the group consisting of scandium and yttrium, as recited in claim 14. Therefore, Rathore et al. does not include each and every recitation of claim 14, so claim 14 should be allowed.

Claim 15 recites a metal layer on a layer of titanium nitride that adjoins a dielectric layer, where the metal layer comprises a copper-rich alloy selected from the group consisting of Cu_4Sc , Cu_6Y , Cu_4Ti , Cu_3Ti and Cu_5Zr . This is different from Rathore et al.

As indicated above in conjunction with claim 1, Rathore et al. includes a thermal diffusion barrier layer 6 that can be a layer of titanium nitride on a layer 5 that is preferably titanium, tantalum, tantalum nitride, tantalum, chromium, tungsten, or any combination of these layers. Rathore et al. includes a layer of copper intermetallic compound 10 (hafnium cupride (Hf_2Cu), lanthanum cupride (LaCu_2), eta-bronze (Cu_6Sn_5), titanium cupride (TiCu) and zirconium cupride (Zr_2Cu)) on layer 6 (Figure 4). This is different than a copper-rich alloy selected from the group consisting of Cu_4Sc , Cu_6Y , Cu_4Ti , Cu_3Ti and Cu_5Zr , as recited in claim 15. Therefore, Rathore et al. does not include each and every recitation of claim 15, so claim 15 should be allowed.

Claims 16-17 depend from claim 15 and are thus allowable for at least the same reasons as claim 15. Therefore, claims 16-17 should be allowed.

Claim 32, as currently amended, recites a layer of a metal alloy nitride on a diffusion barrier layer, where the layer of metal alloy nitride has a first metal component, a second metal

component that can form a crystalline compound with the first metal component, and nitrogen. This is different from Rathore et al.

The Examiner has taken layer 5 (Figures 3 and 4, column 8, lines 1-3 of Rathore et al.) of an adhesive and contact metal as corresponding to the diffusion barrier layer of claim 32. The Examiner has combined layer 6 (Figures 3 and 4, column 8, lines 5-9) of a material, such as chromium-chromium oxide, tungsten-silicon, tungsten-nitride, tungsten-nitride-silicon, titanium-nitride, tantalum or tantalum-nitride, with a layer 7 of an element that is capable of forming an intermetallic compound with copper (Figure 3, column 8, lines 31-35), and has taken combined layer 6/7 to correspond to first metal layer of claim 32. In fact, the Examiner has apparently combined a copper seed layer 8 (Figure 3, column 8, lines 37-38) with layers 6 and 7 and taken the combined layer 6/7/8 to correspond to the first metal layer of claim 32 in that he refers to layer 8 as the second metal compound of the first metal layer. Heating causes layer 7 to react with copper to form a layer of copper intermetallic compound 10 on layer 6 (Figure 4 and column 8, lines 61-67). However, layer 7 is not a metal alloy nitride, nor are layers 6 and 7 in combination a metal alloy nitride, nor are layers 6, 7, and 8 in combination a metal alloy nitride. Therefore, Rathore et al. does not include each and every recitation of claim 32, so claim 32 should be allowed.

Claims 33-36 depend from claim 32 and are thus allowable for at least the same reasons as claim 32. Therefore, claims 33-36 should be allowed.

Claim Rejections Under 35 U.S.C. § 103

Claims 8-10, 18-22, and 37-48 were rejected under 35 U.S.C. § 103(a) as being unpatentable over Rathore et al. Applicant respectfully traverses.

Claim 7 is patentable over Rathore et al. Claims 8-10 depend from claim 7 and are thus allowable for at least the same reasons as claim 7. Therefore, claims 8-10 should be allowed.

Claim 15 is patentable over Rathore et al. Claims 18-20 depend from claim 15 and are thus allowable for at least the same reasons as claim 15. Therefore, claims 18-20 should be allowed.

Claims 21 and 22, as currently amended, each recite a first metal layer on a layer of titanium nitride, where the first metal layer includes elemental copper, where the first metal layer further comprises a copper-rich crystalline alloy compound containing copper and a metal component selected from the group consisting of scandium and yttrium. This is different from Rathore et al.

As indicated above in conjunction with claims 1 and 14, layer 5 of Rathore et al. is preferably titanium, tantalum, tantalum nitride, tantalum, chromium, tungsten, or any combination of these layers. None of these layers or combinations thereof is a layer of titanium nitride. However, as indicated above, thermal diffusion barrier layer 6 of Rathore et al. can be a layer of titanium nitride. As further indicated above, a layer 7 of an element (hafnium, lanthanum, zirconium, tin and titanium) that is capable of forming an intermetallic compound with copper is disposed on layer 6. However, there is no indication or suggestion in Rathore et al. of a metal component forming a crystalline compound with copper, where the metal component is selected from the group consisting of scandium and yttrium, as recited in claim 21 or 22. Therefore, Rathore et al. does not include each and every recitation of claim 21 or 22, and claims 21 and 22 should be allowed.

Claim 37 recites a nitrided metal layer on a layer of titanium nitride, where the nitrided metal layer has a nitride metal alloy compound containing a first metal component, a second metal component and nitrogen, where the second metal component is selected from the group consisting of Group IIIA and Group IVA elements. This is different from Rathore et al.

As indicated above in conjunction with claim 1, layer 5 of Rathore et al. is preferably titanium, tantalum, tantalum nitride, tantalum, chromium, tungsten, or any combination of these layers. None of these layers or combinations thereof is a layer of titanium nitride. However, as indicated above, thermal diffusion barrier layer 6 of Rathore et al. can be a layer of titanium nitride. As further indicated above, a layer 7 of an element (hafnium, lanthanum, zirconium, tin and titanium) that is capable of forming an intermetallic compound with copper is disposed on layer 6; a thin copper seed layer 8 is formed on layer 7; and a copper layer 9 is formed on copper seed layer 8. Heating causes the layer 7 to react with the copper layers to form a layer of copper intermetallic compound 10 (hafnium cupride (Hf_2Cu), lanthanum cupride (LaCu_2), eta-bronze

(Cu₆Sn₅), titanium cupride (TiCu) and zirconium cupride (Zr₂Cu)) on layer 6. However, the layer of copper intermetallic compound 10 formed on layer 6 is not a nitrided metal layer that has a nitride metal alloy compound containing a first metal component, a second metal component and nitrogen, where the second metal component is selected from the group consisting of Group IIIA and Group IVA elements, as recited in claim 37, nor are layers 6, 7, and 8, alone or in combination. Therefore, Rathore et al. does not include each and every recitation of claim 37, so claim 37 should be allowed.

Claims 38-40 depend from claim 37 and are thus allowable for at least the same reasons as claim 37. Therefore, claims 38-40 should be allowed.

Claim 41 recites a layer of a metal alloy nitride on a titanium nitride layer, where the layer of metal alloy nitride has copper, a metal component that can form a crystalline compound with the copper, and nitrogen, where the metal component is selected from the group consisting of scandium, yttrium, lanthanum, titanium, zirconium and hafnium. This is different from Rathore et al.

As indicated above in conjunction with claim 1, layer 5 of Rathore et al. is preferably titanium, tantalum, tantalum nitride, tantalum, chromium, tungsten, or any combination of these layers. None of these layers or combinations thereof is a layer of titanium nitride. However, as indicated above, thermal diffusion barrier layer 6 of Rathore et al. can be a layer of titanium nitride. As further indicated above, a layer 7 of an element (hafnium, lanthanum, zirconium, tin and titanium) that is capable of forming an intermetallic compound with copper is disposed on layer 6; a thin copper seed layer 8 is formed on layer 7; and a copper layer 9 is formed on copper seed layer 8. Layer 7 is not a metal alloy nitride. Combining layers 7 and 8 does not form a metal alloy nitride, nor does combining layers 6, 7, and 8, for that matter. Therefore, Rathore et al. does not include each and every recitation of claim 41, so claim 41 should be allowed.

Claim 42 depends from claim 41 and is thus allowable for at least the same reason as claim 41. Therefore, claim 42 should be allowed.

Claims 43, 46, and 47 each recite a nitrided metal layer on a layer of titanium nitride, where the nitrided metal layer is of the form MT_xN_y, where M is a first metal component (claims

43 and 46) or the form CuT_xN_y , where Cu is copper (claim 47), T is a Group IIIA or Group IVA transition metal, N is nitrogen. This is different from Rathore et al.

As indicated above in conjunction with claim 1, layer 5 of Rathore et al. is preferably titanium, tantalum, tantalum nitride, tantalum, chromium, tungsten, or any combination of these layers. None of these layers or combinations thereof is a layer of titanium nitride. However, as indicated above, thermal diffusion barrier layer 6 of Rathore et al. can be a layer of titanium nitride. As further indicated above, a layer 7 of an element (hafnium, lanthanum, zirconium, tin and titanium) that is capable of forming an intermetallic compound with copper is disposed on layer 6; a thin copper seed layer 8 is formed on layer 7; and a copper layer 9 is formed on copper seed layer 8. Heating causes the layer 7 to react with the copper layers to form a layer of copper intermetallic compound 10 (hafnium cupride (Hf_2Cu), lanthanum cupride (LaCu_2), eta-bronze (Cu_6Sn_5), titanium cupride (TiCu) and zirconium cupride (Zr_2Cu)) on layer 6. However, the layer of copper intermetallic compound 10 formed on layer 6 is not form MT_xN_y , where M is a first metal component or CuT_xN_y , where Cu is copper, T is a Group IIIA or Group IVA transition metal, N is nitrogen, nor are layers 6, 7, and 8, alone or in combination. Therefore, Rathore et al. does not include each and every recitation of claim 43, 46, or 47, so claims 43, 46, and 47 should be allowed.

Claims 44-45 depend from claim 43 and are thus allowable for at least the same reasons as claim 43. Claim 48 depends from claim 47 and is thus allowable for at least the same reason as claim 47. Therefore, claims 44-45 and claim 48 should be allowed.

Allowable Subject Matter

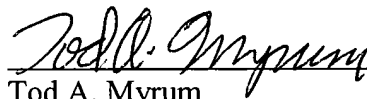
Applicant acknowledges that claims 23-31 and 49-54 were allowed.

CONCLUSION

In view of the above remarks, Applicant believes that the claims are in condition for allowance and respectfully requests a Notice of Allowance be issued in this case. If the Examiner has any questions regarding this application, please contact the undersigned at (612) 312-2208.

Respectfully submitted,

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Tod A. Myrum
Reg. No. 42,922

Attorneys for Applicant
Leffert Jay & Polglaze
P.O. Box 581009
Minneapolis, MN 55458-1009
T 612 312-2200
F 612 312-2250